DOCUMENT RESUME

ED 092 709 CE 001 438

TITLE	Automotive Air Conditioning and Heating; Automotive Mechanics (Advanced): 9047.04.
INSTITUTION	Dade County Public Schools, Miami, Fla.
PUB DATE	Dec 72
NOTE	23p.; An Authorized Course of Instruction for the Quinmester Program
EDRS PRICE	MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS	Air Conditioning; *Air Conditioning Equipment; *Auto Mechanics; Course Content; Course Objectives; *Curriculum Guides; *Equipment Maintenance; Heating; Inspection; Job Skills; Performance Criteria; *Technical Education
IDENTIFIERS	Florida; *Quinmester Program

ABSTRACT

This document presents an outline for a 135-hour course designed to provide the student with all the foundations necessary to become employable in the automotive air conditioning and heating trade. The course of study includes an orientation to the world of work, the elementary physics of air conditioning and heating, and laboratory experiments which stress the manipulative skills of testing, diagnosis, repair, and maintenance of automotive air conditioning and related systems. The behavioral objectives and performance standards necessary for a person to become an automotive air conditioning technician are specified. A twelve-item bibliography, a list of five films, and a Quinmester post test sample are included. (KP)

ED 092709

AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

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Course Outline
AUTOMOTIVE MECHANICS - ADVANCED - 9047
(Automotive Air Conditioning and Heating)
Department 48 - Quin 9047.04

CE001438 duplicate

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION • 1973

ED 092709

D A D E C O U N T Y P U B L I C S C H O O L S

1 4 5 0 N O R T H E A S T S E C O N D A V E N U E

M I A M I, F L O R I D A 33132

Course Outline

AUTOMOTIVE MECHANICS - ADVANCED - 9047
(Automotive Air Conditioning and Heating)

Department 48 - Quin 9047.04

county office of

VOCATIONAL AND ADULT EDUCATION

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December, 1972

Published by the School Board of Dade County

Copies of this publication may be obtained through

Vocational Curriculum Materials Service
Rm. 710, 1410 N. E. Second Avenue
Miami, Florida 33132

Course Description

9047	48	9047.04	Automotive Air Conditioning and Heating
State Category Number	Course Dept. Number	County Course Number	Course Title

This course of study includes elementary physics of air conditioning and heating. Comprehensive laboratory experiments relating to the text will be covered. The manipulative skills of testing, diagnosis, repair and maintenance of automotive air conditioning will be stressed. This is a two or three quinmester credit course.

Indicators of Success: Prior to entry into his course, the vocational student will display mastery of the skills indicated in Automotive Power Flow System II (9047.03)

Clock Hours: 135

PREFACE

The following quinmester course outline is designed to provide the student with all the foundations necessary to become employable in the automotive air conditioning and heating trade. Through shop experiences, skills, knowledge, attitudes and values necessary for performing the required services, will be instructed. Upon completion of this quinmester course, the student will be grounded in the areas of air conditioning theory, diagnosis, servicing and reconditioning the system.

This outline consists of five blocks of instruction which are subdivided into several units each. The course is 135 clock hours in length.

The teaching methods vary according to the ability of the individual student. As the content of the course varies, teaching techniques, which lend themselves to each particular situation, are employed. The instructor uses demonstrations and lectures which are supplemented by the performance of shop experiments and assignment by the student. The instruction is further developed by the use of films, information sheets, diagrams and other aids which make the instruction more meaningful. Students will disassemble, service and adjust instructional units with the close supervision of the instructor. Service problems will be handled by the student as the instructor will accept live work on a production basis.

Testing is done frequently to determine the degree of progress and should be mandatory in order to point out weak areas of student's comprehension. Reinforcement of these areas should be stressed prior to further advancement of instruction.

The bibliography appearing on the last page of this outline lists several basic references along with supplementary references and audiovisual aids.

This outline was developed through the cooperative efforts of the instructional and supervisory personnel, the Quinmester Advisory Committee and the Vocational Curriculum Materials Service, and has been approved by the Dade County Vocational Curriculum Committee.

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with Suggested Hourly Breakdown

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GOALS

The student must be able to demonstrate:

1. The skills and knowledge required to perform maintenance, service and repairs on the automotive air conditioning and heating system, and their related systems.

2. The ability for accuracy and precision when troubleshooting and making a diagnosis of the air conditioning and heating system, and their related systems.

3. Positive attitudes regarding the value and dignity of work.

4. Pride and respect of craftsmanship for this occupational field.

5. Safe work habits and proper shop behavior to guard against accidents.

6. An incentive to continue with more advanced training within this occupational field.

SPECIFIC BLOCK OBJECTIVES

BLOCK I - ORIENTATION

The student must be able to:

1. Exhibit a positive attitude toward the world of work by following safety rules, good shop practices and taking pride in his workmanship.
2. Explain orally or in writing what will be expected of him as an automotive air conditioning mechanic.
3. Demonstrate understanding of what is expected of him behaviorally throughout the course, acceptance of his own duties and responsibilities by performing that which is expected of him.

BLOCK II - REFRIGERATION FUNDAMENTALS

The student must be able to:

1. Discuss the history and principles of automotive air conditioning and heating.
2. Describe orally or in writing the basic fundamentals of the air conditioning system.
3. Explain the air conditioning circuit and its function within the system.
4. List the major components of the air conditioning system and the various types of control devices.
5. Discuss the theory of heat transfer in terms of solids, liquids and gases.
6. Explain the relation of vapor to saturated and super heated vapors and define latent heat as it is applicable to the air conditioning system.
7. Demonstrate the proper care and maintenance of hand tools, special tools and test equipment.
8. Perform maintenance service, repair and adjustments to the related components of the air conditioning system.
9. Demonstrate the use of the applicable tools and equipment by performing the bench skills in the proper manner.

BLOCK III - SERVICING THE REFRIGERANT SYSTEM

The student must be able to:

1. Demonstrate the proper usage and understanding of the principles of the manifold gage set.
2. Explain the operation of the vacuum pump and the leak detector.
3. Perform the skills that are needed to operate and use the vacuum pump and the leak detector satisfactorily.
4. Perform minor adjustments, charging the system necessary to return the air conditioning system to factory specifications.

BLOCK IV - SERVICING THE AIR CONDITIONING COMPRESSOR

The student must be able to:

1. Identify the various types of compressors used in the modern automobile.
2. Use the proper tools and equipment to complete a satisfactory reconditioning of the air conditioning compressor units.
3. Overhaul and replace faulty parts making any adjustments necessary to return the compressor to factory specifications.
4. Practice recommended safety precautions in making final reassemble and testing on vehicles to factory specifications.
5. Demonstrate the ability to troubleshoot the air conditioning system.

BLOCK V - QUINMESTER POST-TEST

The student must be able to:

1. Satisfactorily complete the quinmester post-test.

Course Outline

AUTOMOTIVE MECHANICS - ADVANCED - 9047
(Automotive Air Conditioning and Heating)

Department 48 - Quin 9047.04

I. ORIENTATION

A. Objectives of the Course
   1. Standards
   2. Methods of evaluation
      a. Written tests
      b. Oral
      c. Manipulation
      d. Diagnosis and job performance
   3. Teaching methods

B. Student Benefits
   1. Opportunities for employment
      a. Scope of the trade
      b. Job opportunities
   2. Qualification for employment
      a. Job competency
      b. Pride in workmanship
      c. Attitude
      d. Dependability
      e. Trade certificate
      f. Foundation for further education and training
      g. Experience

C. Student Responsibilities
   1. School policies and expenses
   2. Safety regulations
   3. Shop rules and procedures
      a. Care of hand tools
      b. Use and care of equipment
      c. Reporting defective equipment
      d. Reporting loss of equipment
      e. Materials and supplies
      f. Housekeeping
      g. Employee-employer relations
      h. Employee-customer relations

II. REFRIGERATION FUNDAMENTALS

A. History of Refrigeration
   1. Definition of refrigeration
      a. Definition of heat
      b. Why heat moves
      c. How heat is transferred to solids, liquids and gases
   2. Definition and use of B.T.U. and degrees of heat

a. Difference between B.T.U. and degrees of heat
b. Sensible heat definition
c. Specific heat tables - their use and purpose
d. Formula uses to determine amount of heat involved in temperature change

3. Latent heat defined and its relationship to
   a. Fusion
   b. Evaporation
   c. Condensation
4. Theory of changes in the state of matter
5. Vapor defined and its relation to
   a. Saturated vapor
   b. Superheated vapor
6. Difference between gas and vapor
7. Definition of energy
8. Pressure defined and its relationship to
   a. Absolute pressure
   b. Gauge pressure
   c. Mercury vacuum
9. Definition and use of Dalton's Law of partial pressure

B. Condensation of Vapor to a Liquid
1. Demonstrate condensation of vapor to a liquid
2. Comparing condensation and evaporation
3. Using tables to determine the amount of B.T.U. necessary for evaporation and condensation

C. Safety Precautions in the Use of Refrigerants
1. Personal
2. Handling of containers
3. Ventilation

D. The Refrigeration Circuit - Components (Typical)
1. Evaporator
2. Compressor
3. Condenser
4. Receiver/drier
5. Expansion valve

E. Electrical Components (Typical)
1. Battery
2. Fuse
3. Rheostat
4. Motor
5. Thermostat
6. Magnetic Clutch coil

F. Refrigeration Oil and Moisture
1. Type used
2. Handling of oil
3. Effect of moisture in refrigeration circuit
4. Removal of moisture in refrigeration circuit
5. Refrigeration service valve
   a. Hand shutoff type valve - three-position operation
   b. Schrader-type valve

II. REFRIGERATION FUNDAMENTALS (Contd.)

6. Service tools, equipment and material
   a. Pullers
   b. Clutch hub and drive plate puller
   c. O'ring and seal installer tools
   d. Leak detector (torch)
   e. Leak detector (electronic)
   f. Service valve wrench
   g. Manifold gage set
   h. Vacuum pump
   i. Charging station
   j. Refrigerant 12
   k. Eye goggles

G. Receiver Dryer
   1. Usage in system
   2. Installation or servicing the dryer

H. Thermostatic Expansion Valve
   1. Location of the thermostatic expansion valve in the A/C system
   2. Refrigeration control through the expansion valve
   3. Major parts of the expansion valve
   4. Removal and reinstallation of the expansion valve
      a. Flare type
      b. O-ring type

I. Thermostat Switch
   1. Location in system and theory
      a. Bellows type
      b. Bimetal type
   2. Major parts of the thermostatic control switch
   3. Precautions of handling and installing thermostat

J. Magnetic Clutch
   1. Stationary field clutch
   2. Rotating field clutch
   3. Ball and ramp clutch
   4. Testing and servicing procedures

K. Temperature Control Devices
   1. Solenoid bypass
   2. Hot gas bypass valves
   3. Suction throttling regulators
   4. Rabotrol valve
   5. Selectrol valve
   6. Temp-trol valve
   7. Evaporator pressure regulator (EPR)
   8. Evaporator temperature regulator (ETR)
   9. Section throttling valve (STV)
   10. Plot-operated absolute valve (POA)
   11. Testing and servicing procedures

L. Automatic Temperature Controls
   1. Electro-pneumatic temperature control
   2. Amplifier
   3. Transducers
   4. Power servo
   5. Electro-thermo hydraulic-pneumatic temperature control
   6. Sensors
      a. In car sensor
      b. Duct sensor
      c. Ambient sensor
   7. Vacuum switches
      a. Temperature door regulator
      b. Program vacuum switch (TDA)

M. Electric and Vacuum Controls
   1. Heater control
   2. Refrigerant pressure control
   3. Mode doors controls
   4. Double-action vacuum motor
   5. Blower control
   6. Ambient switch
   7. Thermostatic vacuum valve (TVV)

III. SERVICING THE REFRIGERANT SYSTEM

A. Manifold Gage Set "Connection"
   1. Hand shutoff service valves
   2. Schrader valve fittings

B. Purging the Air Conditioning System

C. Evacuating the Air Conditioning System
   1. Vacuum pump
   2. Charging station

D. Leak Testing
   1. Halide leak detector (torch)
   2. Electronic leak detector

E. Charging System
   1. System off
   2. System running
   3. Bulk source charging
   4. Charging station dispenser
   5. Safety precautions
   6. Isolation of refrigerant from compressor
   7. Performance testing air conditioning
      a. Manufacturers' specifications
      b. Volumetric test of compressor

IV. SERVICING THE AIR CONDITIONING COMPRESSOR

A. York Compressor
   1. Compressor shaft oil seal
   2. Head and valve plate
   3. Pistons and connecting rods
   4. Crankshaft and main bearings
   5. Oil pump assembly

B. Tecumseh Compressor
   1. Compressor shaft oil seal
   2. Head and valve plate
   3. Piston and connecting rods
   4. Crankshaft and main bearings
   5. Oil pump assembly

C. Chrysler Air-Temp V-2 Compressor
   1. Compressor shaft oil seal
   2. Head and valve plate
   3. Piston and connecting rods
   4. Crankshaft and main bearings
   5. Oil pump assembly
   6. EPR or ETR valves

D. General Motors Compressor
   1. Pistons
   2. Piston drive balls
   3. Piston rings
   4. Shoe discs, sizes
   5. Thrust races, sizes
   6. Main shaft bearings
   7. Thrust bearings
   8. Compressor shaft
   9. Suction reed valves
   10. Discharge reed valves
   11. Pulley bearings
   12. Oil pump drive and gears
   13. Manufacturers specifications

E. Air Conditioning Systems Diagnosis and Troubleshooting
   1. Electrical troubleshooting
   2. Troubleshooting liquid lines
      a. Repair of hose connections
      b. Repair of tubing and adaptors
      c. Silver soldering
   3. Flaring methods
      a. Single flare
      b. Double flare

V. QUINMESTER POST-TEST

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7. General Motor Service Manual. Detroit: General Motors Corporation. Yearly.

8. Glenn Auto Repair Manual. Philadelphia: Chilton Company. Yearly.

9. Motors Auto Repair Manual. New York: Motor Magazine. Yearly.

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1. Adjusting and Repairing the Thermostatic Expansion Valve. 16 mm. 12 min. B/W. United World Films, Inc. 1-05422.

2. Laws of Gases. 16 mm. 11 min. Color. Coronet Films, 1-01831.

3. Making and Repair Tubing Connections. 16 mm. 18 min. B/W. United World Films, Inc. 1-13070.

4. Principles of Refrigeration. 16 mm. 20 min. B/W. United World Films, Inc. 1-13116.

5. Thermodynamics. 16 mm. 11 min. B/W. Encyclopedia Britannica Films, Inc. 1-05588.

A P P E N D I X

Quinmester Post-Test Sample

QUINMESTER POST-TEST

Name _____ Date _____ Score ____

Multiple Choice Test Items

Each statement needs a word, a figure, or a phrase to make it correct. Only one of the choices listed is correct. Place the letter of the choice you make in the space provided at the left edge of the sheet.

1. What is the basic operating principles of an air conditioning system:

   a. Refrigerant absorbs heat when placed under pressure
   b. Refrigerant absorbs heat when it changes from a gas to a liquid.
   c. Refrigerant absorbs heat when it changes from a liquid to a gas.
   d. None of the above.

2. What is the means of measuring latent heat:

   a. Thermometer
   b. Pyrometer
   c. British thermal unit
   d. Bimetal sensing unit

3. What do we mean by ambient temperature:

   a. The absence of heat
   b. Atmosphere temperature
   c. Radiant heat through a conductor
   d. None of the above

4. What is atmospheric pressure at sea level:

   a. 14.7 psi
   b. 14.8 psi
   c. 14.9 psi
   d. 15.0 psi

5. Above atmospheric pressure all pressures are referred to as:

   a. Altitude pressures
   b. Foot pounds of pressures
   c. Inch pounds of pressures
   d. Gage pressures

6. What refrigerant is commonly used in an automobile air conditioning system?

   a. Ammonia
   b. Freon
   c. Carbon dioxide
   d. None of the above apply

7. What does refrigerant 12 smell like:

   a. Mustard gas
   b. Engine oil
   c. Carbon tetrachloride
   d. Ammonia

8. What is the main function of the evaporator:

   a. Removes heat from the refrigerant
   b. Absorbs heat from the passenger compartment
   c. Absorbs moisture from the refrigerant
   d. None of the above

9. In addition to cooling the air inside the car, the air conditioning system:

   a. Dries the air
   b. Dampens the air
   c. Cools the engine radiator
   d. Supplies cool air to the carburetor air cleaner

10. In an air conditioning system, the refrigerant changes from a liquid to a gas in the:

   a. Compressor
   b. Condenser
   c. Evaporator
   d. Receiver drier

11. What is the state of refrigerant when its pumped from the compressor to the condenser:

   a. Liquid
   b. Gas
   c. Liquid and gas
   d. Vapor

12. What is indicated if bubbles appear in the sight glass:

   a. System is overcharged with refrigerant
   b. System is low on refrigerant
   c. System is fully discharged
   d. None of the above apply

13. Using a manifold gauge set, how can you tell the need for recharging:

   a. "Low" gauge reads very low
   b. "Low" gauge reads very high
   c. "High" gauge reads very low
   d. None of the above

14. What is the most common problem with a condenser:

a. Freezing of coils
b. Clogging of fins
c. Leaking of refrigerant
d. None of the above

15. Which unit generally requires replacement if the air conditioning system is opened for repairs:

a. Expansion valve
b. Evaporator
c. Receiver-dryer
d. E.P.R. valve

16. What is the main purpose of the expansion valve:

a. To meter refrigerant throughout the system
b. To control refrigerant passage through the compressor
c. To vent the system when pressure build up is highest within the evaporator assemble
d. None of the above

17. The compressor only operates when the engine is:

a. Running
b. The electromagnetic clutch is engaged
c. Air conditioning switch is depressed to the on position
d. None of the above

18. How are compressor bearings oiled:

a. Splash oiling
b. Circulation oiling
c. Oil pump
d. None of the above

19. What causes oxidation of the refrigerant oil:

a. Water
b. Air
c. Heat
d. Refrigerant

20. What care should be given lubricating oil:

a. Keep in dry storage area
b. Vent container so moisture can evaporate
c. Keep container at room temperature to preserve moisture-free qualities
d. Make sure air space is provided to allowing for expansion

21. What causes high compressor temperatures or head pressure:

a. Air in the system due to leakage
b. Open expansion valve
c. Excessive refrigerant in the system
d. Blockage of the condenser

22. What is indicated when the suction line frosts back to the compressor manifold:

a. The expansion valve is not opening enough
b. The expansion valve is open too wide
c. Excessive refrigerant in the system
d. System low on refrigerant

23. What causes low head pressure in the air conditioning system:

a. Condenser is too hot
b. Expansion valve is open too wide
c. Low refrigerant
d. None of the above

24. When working around refrigerant, you should always wear:

a. Gloves, safety
b. Long sleeve shirts
c. Hair net, safety
d. Safety glasses

25. At what engine speed should an operational test of the air conditioning system be performed:

a. 500 rpm
b. 1000 rpm
c. 1500 rpm
d. 2000 rpm

26. What is considered to be an important factor, aside from having the proper tools, in rebuilding a compressor:

a. A test bench
b. Having the necessary materials to complete the repair
c. Knowledge of the assemble
d. A clean area to work in

27. What parts must be removed to replace the valve plate assembly of the Tecumseh compressor:

a. Electromagnetic clutch
b. Crankshaft front seal assembly
c. Cylinder head assemble
d. Rear bearing housing cover plate

28. Why is it necessary not to touch the carbon face of the crankchaft seal:

a. Rust will form on the seal from moisture on your hands
b. The carbon is soft and you may leave a depression in its surface
c. Carbon from the seal may be transferred to other parts that have gotten on your fingers
d. None of the above

29. Where is the E.P.R. valve located on Chrysler automotive air conditioning systems:

a. Behind the expansion valve
b. In the compressor assembly
c. In the evaporator assembly
d. In the condenser assembly

30. What, in your opinion, would result if the idle pulley were not in line with the compressor clutch and drive pulley:

a. The compressor would not disengage when the car is at idle speed
b. The compressor would work loose from its mounting bracket
c. Compressor belts would wear uneven
d. Drive belts would break or spin-off the drive pulley at any rpm.

ANSWER KEY TO QUINMESTER POST-TEST

1.	c	16.	d
2.	c	17.	b
3.	b	18.	c
4.	a	19.	b
5.	d	20.	c
6.	b	21.	a
7.	c	22.	b
8.	b	23.	c
9.	a	24.	d
10.	c	25.	c
11.	b	26.	d
12.	b	27.	c
13.	a	28.	a
14.	b	29.	b
15.	c	30.	d